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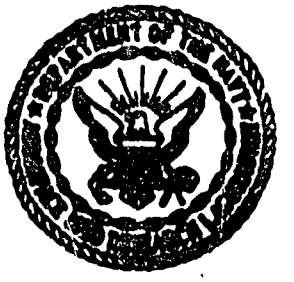

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SUMMARY PAGE

THE PROBLEM

The need for supplementary noncognitive background information in the selection of naval aviation students has become increasingly evident. Recent exit interviews with student pilots who have voluntarily withdrawn from training indicate that factors unrelated to mental ability (such as attitude toward the military) often entered into their decisions. This study was conducted to determine if inclusion of the noncognitive items of the college and flight background questionnaires would enhance the validity of the existing primary selection process, thus reducing the current attrition rate.

FINDINGS

Certain items of the college and flight background questionnaires, when coupled with the residual validity of the existing selection tests, were found to increase the predictive validity of the current selection system. The prediction equation developed on half of the sample was successfully crossvalidated with the remaining half. Implementation of the suggested technique would have reduced the attrition rate by 4.5 percentage points in the cross-validation sample. Thus, it was recommended that this technique be incorporated as a management tool at the primary selection level.

INTRODUCTION

The traditional psychological selection instruments utilized for naval aviation students are primarily cognitive in nature. The underlying assumption is that if an applicant has the mental and physical capability, he can succeed in flight training. The Navy currently employs a battery of four selection tests and a flight physical for this purpose. The tests are the Aviation Qualification Test (AQT), the Mechanical Comprehension Test (MCT), the Spatial Apperception Test (SAT), and the Biographical Inventory (BI). The last is the only one in which a noncognitive approach is applied.

Recent exit interviews with naval aviation students who have voluntarily dropped from the flight program indicate that factors unrelated to mental ability often entered into their decision. This has led to the notion that supplementary noncognitive background information may prove beneficial in the selection process.

This paper reports an investigation of the effectiveness of the Flight Background Questionnaire (FBQ) and the College Background Questionnaire (CBQ) in the establishment of an additional standard for the elimination of a greater proportion of applicants with the least likelihood of success, thus decreasing the current attrition rate and improving cost effectiveness in aviation training. A previous study conducted at the Naval Aerospace Medical Institute found college major to be predictive of success in the flight program (3). At the time of that study the CBQ was developed (2). Subsequently, the FBQ was constructed (1) with a format similar to that of the CBQ. These instruments were designed to provide a means of exploring background information relevant to the successful completion of flight training.

PROCEDURE

MATERIALS

The CBQ is composed of the questions that cover the following topics: 1) the highest level of education attained; 2) college major; 3) the type of school attended (e.g., state supported, church affiliated, or private); 4) the number of students attending the college; 5) the number of colleges attended; 6) grade point average; 7) the number of times one changed academic major; 8) the geographical location of the college where one completed the major part of his work; and 9) whether or not one has a teacher's certificate. Each item has two or more alternatives, the most being ten. Only one selection is made for each question. In all, there are 59 alternatives across the nine items.

The FBQ is similarly constructed and is composed of five items. These include: 1) experience as an airline passenger, 2) experience as an aircrewman, 3) previous flight instruction, 4) collegiate aviation activities, and 5) the age at which one first became motivated to go into military aviation. There are 22 alternatives across the five items.

Of the 81 alternatives some were eliminated and several were combined to make up 22 separate experimental items. The reduction of the CBQ was based in part on an unpublished item analysis by Peterson, Lane and Booth. Since no previous work had been done on the FBQ, the items were allowed to stand as they existed except for a few minor changes. Items answered in the affirmative were scored with a value of 1 and a negative response was scored as 0.

SUBJECTS

The study sample consisted of 1207 aviation officer candidates (AOC's) who entered flight training during calendar years 1966 and 1967. AOC's are typically recent college graduates procured directly from civilian life and, as a result, generally have no previous military experience. They represent the largest single source of input to naval aviation training and also account for much of the attrition. Attrition here refers to those students who were removed from training because of academic or flight difficulties and those who voluntarily withdrew from the program. Those who did not complete for reasons other than those mentioned above, such as medical or disciplinary problems, were excluded from the analysis. Of this sample, 769 finished training and 438 attrited.

HYPOTHESIS

It was expected that the inclusion of the noncognitive college and flight background information in the initial selection process would significantly enhance the validity of the current selection process and thus reduce the rate of attrition. Confirmation of this hypothesis should lead to the implementation of a cut-off-score approach to selection. This cut-off score would represent a minimum standard required for selection. This technique would hopefully reduce the current attrition rate and thus result in a valuable savings to the Navy.

DATA ANALYSIS

The sample was divided into two groups by an odd-even method. Half were utilized for the initial analysis, and the remainder for cross-validation. The initial validation sample consisted of 602 students, 375 of whom completed and 227 of whom attrited. The cross-validation sample consisted of 605 students, 394 of whom completed and 211 of whom attrited. Two multiple correlation coefficients were calculated for the initial sample with the complete-attrite dichotomy used as the criterion. The first multiple correlation examined the primary selection tests only, and the second included both the primary selection tests and the experimental CBQ and FBQ items with each item treated as a separate variable. This was done to determine whether or not the inclusion of the experimental variables significantly increased the multiple correlation coefficient.

Regression scores (predictor scores) were then computed with the regression weights obtained from the first sample for each subject in the cross-validation sample. The point biserial correlation coefficient between these predictor scores and the complete-attrite criterion served as an index of crossvalidation.

The final step was to demonstrate the utility of the inclusion of the CBQ and FBQ items in the selection process by compiling actuarial data. This was done by dividing the cross-validation sample into those who completed and those who did not complete. Separate frequency distributions of predictor scores were set up for each group. The frequency distributions indicated the percentage of those who completed and the percentage of those who attrited at or below a given predictor score. In this manner, a cutting score that would eliminate the maximum number of potential "attrites" while allowing for the retention of the greatest number of "completes" could be identified.

RESULTS AND DISCUSSION

A review of the descriptive statistics from the initial validation sample is included in Tables I and II. The means and standard deviations of the primary selection variables are included in Table I, with their point biserial correlations with the complete-attrite criterion.

Table I

Statistics from Initial Validation Sample
with Regard to Primary Selection Tests

Test	Mean	s. d.	r
AQT	84.430	11.444	.048
MCT	60.437	7.357	.177*
SAT	22.131	4.874	.054
BI	39.957	12.556	.141*

* Significant beyond the .01 level

N = 602

These correlations represent the residual validity of the selection tests. That is, their ability to predict to a criterion for a group that had previously been screened by

these same measures. Table II lists for the experimental items on the CBQ and FBQ the proportion of the initial validation sample responding in the affirmative and its *phi* coefficient with the criterion.

Table II

Proportion of Initial Validation Sample Responding to Each Experimental CBQ and FBQ Item and Respective Correlations (phi) with the Complete-Attrite Criterion

Experimental Item	Proportion Responding In Affirmative	phi
College major (math, physics, engineering, Mil. Acad.)	.173	.076
College major (business, econ., hist., poli. sci.)	.429	-.016
College population greater than 16,000	.228	.073
Attended three or more colleges	.095	-.087
Grade point average 2.00-2.49	.522	.102
Grade point average 2.50-2.99	.367	-.080
Changed academic major less than twice	.819	.024
College located in East, South, Central State	.081	-.018
College located in Pacific State	.173	.085
Flown less than twice commercially	.055	.053
Flown more than nine hours commercially	.738	.009
Flown light plane, but not solo	.056	.013
Soloed light plane, but no private license	.058	.033
Has private license	.055	.113*
Has commercial license	.010	.078
Member of college flying club	.073	-.004
Age first motivated to fly in military:		
22 or older	.254	-.079
18-21	.498	.011
15-17	.098	.096
14-16	.047	.010
12 or younger	.043	.048
Never sure about desire	.051	.014

* Significant beyond the .05 level

N = 602

Although only one of the phi values is statistically significant, many of the items are independent of each other, and it is possible that they can combine to result in a meaningful multiple correlation coefficient. The complete zero-order correlation matrix is presented in Appendix A.

Tables III and IV illustrate the resultant increase in predictive validity obtained by the addition of the CBQ and FBQ variables. The multiple correlation of the selection tests alone is given in Table III. This value represents the residual validity resulting from the interaction of the MCT and BI. The fact that the BI was selected as a predictor variable supports the notion that noncognitive measures have untapped potential as indicants of eventual success in flight training. Table IV summarizes the output of the multiple correlation, using the two selection tests and the experimental items as predictors.

The resultant coefficient is significantly greater than that obtained by the selection tests alone ($p < .01$). Table IV also lists the variables that were selected as predictors of the criterion. Of the 11 CBQ and FBQ variables selected, eight were assigned positive weights and three were assigned negative weights. The fact that the item "Member of college flying club" was assigned a negative weight was some cause for concern, especially in view of its significant positive correlation with "Private pilot's license" (see Appendix A). Typically, those variables appearing in the latter portions of a multiple correlation listing are unstable and should not be accepted without question. It was decided, however, to report all of the available information in this analysis so, those last few variables were included in the computation of predictor scores. Appendix B lists the weights assigned each predictor variable and the computation of predictor scores is explained there in detail.

The results obtained for the initial validation sample were upheld by cross-validation. The predictor scores calculated for the cross-validation sample had a point biserial correlation coefficient of .193 with the complete-attrite criterion ($p < .001$). This may be interpreted as an indication of the validity of the selected CBQ and FBQ items combined with the MCT and BI for an independent sample.

Table III

Multiple Point-Biserial Correlation between Selected Aptitude Tests and Complete-Attrite Criterion *

Selected Aptitude Test	Shrunken R	F-Value
MCT	.173	19.443
BI	.221	12.914

*N = 602

Table IV

Multiple Point-Biserial Correlation between the Aptitude Tests (MCT and BI), the CBQ and FBQ Items, and the Complete-Attrite Criterion*

Selected Aptitude Tests and CBQ-FBQ Items	Shrunken R	F-Value
MCT	.173	19.443
BI	.221	12.914
Grade point average 2.00-2.49	.239	6.384
Private pilot license	.251	4.893
Motivation to fly military since age 22**	.263	4.969
Attended three or more colleges**	.270	3.264
College located in a Pacific Coast state	.278	3.905
Commercial pilot's license	.284	3.235
Flown less than twice commercially	.291	3.284
Member of college flying club**	.295	2.674
Motivation to fly military since age 15-17	.298	2.153
Attended college with more than 16,000 students	.300	2.076
Motivation to fly military since before age 12	.301	1.067

*N = 602

** Assigned a negative weight

Once validation was established, a practical application of the findings was examined. Table V lists an abridged version of the frequency distributions of predictor scores that were computed for the completes and attrites of the cross-validation sample.

Table V

Frequency Distribution of Predictor Scores
For Completes and Attrites of Cross-Validation Sample (N = 605)

Predictor Score	% of Attrites Below Corresponding Predictor Score	% of Completes Below Corresponding Predictor Score
656	1	1
761	11	3
866	34	16
956	69	39
1061	77	64
1151	90	84
1256	99	94
1361	100	98

Separate cumulative percentages of completes and attrites are presented for representative predictor scores. An examination of these data revealed that cutting at a predictor score of 866 would provide for the elimination of 34 per cent of the attrites at a cost of 16 per cent of the completes. The loss of the potential successes can be called selection error or false positives. Since perfect predictors have yet to be developed, selection systems must operate with a certain amount of error. In a high supply-low demand situation an organization can afford very stringent selection. The false positives who are rejected would be in excess of the demands of the selector. The converse is true, of course, when the supply and demand situation is reversed. Another factor to be considered is the dollar cost of false negatives (those who were selected and then attrited). Due to the extreme expense of training a single naval aviator it is judicious to eliminate potential failures as early as possible. Had a cutting score of 866 been in effect, the attrition rate of the cross-validation sample would have been reduced from 34.7 per cent to 30.2 per cent. This reduction of 4.5 percentage points amounts to a 13 per cent reduction of the original attrition rate. This would represent a large savings to the Navy inasmuch as it could be implemented at the recruiter level of selection.

Another method of utilizing the predictor score approach is demonstrated in Table VI. Here, the percentage of candidates completing flight training is shown for given predictor score intervals. Though there is some fluctuation due to error of measurement, in general the higher the predictor interval, the greater proportion of students completing training. A table such as this provides the user with an estimate of the probability of an applicant successfully completing. For example, a candidate with a predictor of 1200 may be assumed to have approximately a 77 per cent chance of finishing the program. This type of table can provide an additional objective input to the existing selection process, and can be considered a potentially useful management tool.

Table VI

For Cent Completing Flight Training at Increasing Predictor Score Levels*

Predictor Score Interval	N**	% Completing Flight Training
699 and below	10	30
700 - 744	27	37
775 - 849	63	54
850 - 924	96	65
925 - 999	108	68
1000 - 1074	110	64
1075 - 1149	95	71
1150 - 1224	53	77
1225 - 1299	25	76
1300 and above	18	83

* Over-all completion rate 65%

** N = Total number of completes and attrites within a given predictor score interval.

CONCLUSION

The hypothesis has been confirmed; namely, that the inclusion of the non-cognitive information provided by the college and flight background questionnaires would significantly enhance the validity of the current selection process, thus reducing the attrition rate. These findings support the notion that it requires more than mental and physical ability to complete flight training. The noncognitive information appears to tap factors in one's personal history that contribute to his over-all make-up. Though such an approach does not directly measure intelligence, aptitude, or ability, it does consider factors that appear to be related to the tendency to succeed in naval aviation training. This tendency is apparently of great importance to one's success in the program. This is evidenced by the trend of voluntary withdrawals who had the required mental and physical capabilities but did not possess a sufficient degree of this tendency to succeed.

The notion that noncognitive predictors are useful has been supported by the repeated success of the Biographical Inventory, the changing nature of recent voluntary withdrawals, and the demonstrated utility of the CBQ and FBQ. Hence, it is recommended that the proposed cut-off score system be implemented in the selection of naval aviation candidates. It should be noted, however, that this supplementary selection approach was developed on a sample that had previously been screened by the current primary selection battery. Therefore, if implemented, it should be applicable only to those applicants who had survived the initial selection process.

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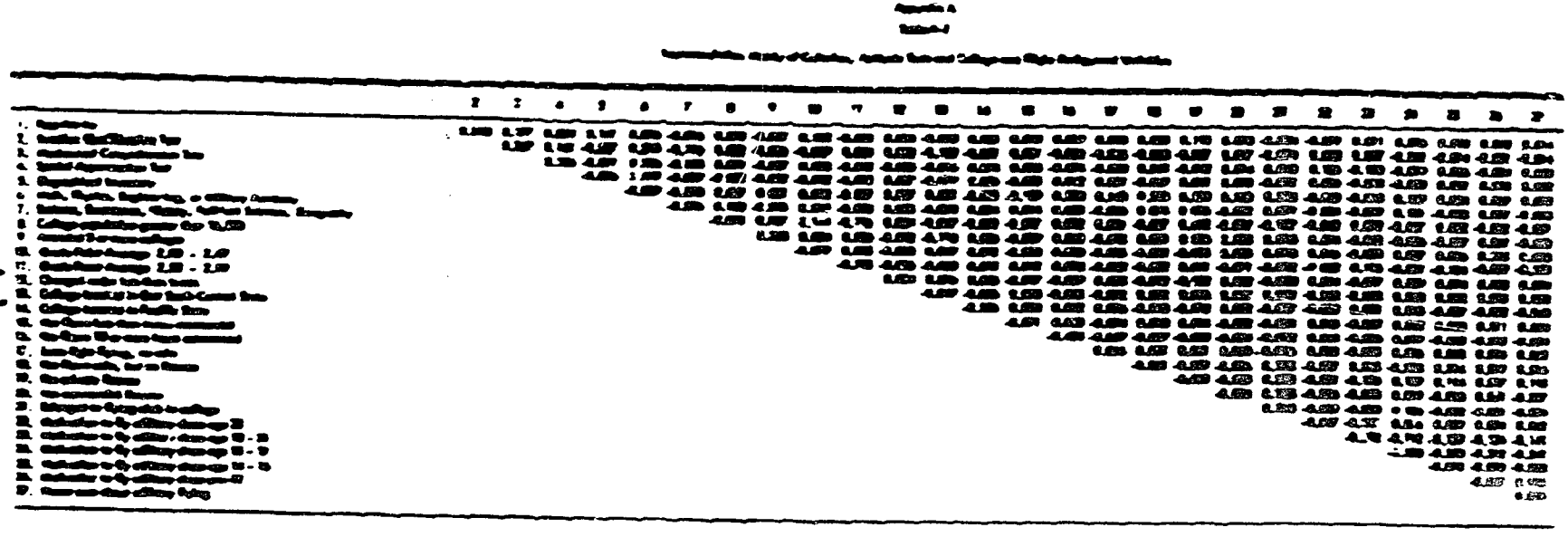

Appendix B

Table B-1

Weights and Constant Utilized in the Computation of Predictor Scores*

Predictor Variable	Weight**
MCT	12
BI	4
Grade point average 2.00 - 2.49	86
Private pilot's license	217
Motivation to fly military since age 22	-87
Attended three or more colleges	-138
College located in a Pacific Coast state	95
Commercial pilot's license	365
Flown less than twice commercially	149
Member of college flying club	-126
Motivation to fly military since age 15 - 17	104
Attended college with more than 16,000 students	63
Motivation to fly military since age 12	98
Constant: +45	

* Predictor scores are calculated as follows: The constant is added to the sum of the products of the scores on each predictor variable and its respective weight. (Note: The CBQ and FBQ items were scored with a value of "1" for an affirmative response and a value of "0" for a negative response.) The constant was included to set the mean predictor score at 1000.

** These weights are rounded whole number versions of those actually assigned each variable by the multiple correlation formula. This was done to facilitate computation.

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13 ABSTRACT

The need for supplementary background information in the selection of student naval aviators has become increasingly evident. Recent exit interviews with students who have voluntarily withdrawn from training indicate that factors unrelated to mental or physical ability (such as attitude toward the military) often entered into their decisions. This study utilized a multiple correlation approach to demonstrate that the inclusion of noncognitive college and flight background information would enhance the sensitivity of the selection process, thus reducing the attrition rate. The initial results confirmed this hypothesis and these findings were upheld by cross-validation. Implementation of the suggested technique would have reduced the attrition rate by 4.5 percentage points for the cross-validation sample. Therefore, it is recommended that this technique be incorporated as a management tool at the primary selection level.

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